REPLACEMENT CLAIMS

WHAT IS CLAIMED IS:

1. A method of generating a theoretical slide displacement curve for a mechanical press, comprising:

providing an equation that can be utilized to calculate slide displacement as a function of press speed, the equation including variables to account for press parameters which effect slide displacement;

providing a computational device;

determining the speed of the press;

determining the equation variables;

communicating the equation, the speed of the press and the equation variables to the computational device;

calculating the theoretical distance above bottom dead center for each increment of a slide stroke; and

plotting the calculated distance above bottom dead center values vs. time.

2. The method of Claim 1, wherein said step of determining the equation variables comprises:

determining the appropriate variable corresponding to the press drive mechanism of the mechanical press;

determining the appropriate variable corresponding to the connecting rod length of the mechanical press;

determining the appropriate variable corresponding to the stroke length of the mechanical press; and

determining the appropriate variable corresponding to the bearing size of the mechanical press.

3. An apparatus for generating a theoretical slide displacement curve for a mechanical press, comprising:

a speed sensor for sensing a value of press speed;

input means for inputting a plurality of variables corresponding to characteristics of the press;

storage means for storing an equation which can be used for generating the theoretical slide displacement curve, said equation utilizing said plurality of variables corresponding to characteristics of the press and said value of press speed to generate the theoretical slide displacement curve; and

computer processor means for generating the theoretical slide displacement curve, said computer processor means communicatively connected to said sensor means, said input means and said storage means.

4. The data processing system as recited in Claim 3, wherein said plurality of variables comprises:

a value of connecting rod length;

a value of stroke length;

a value of drive type; and

a value of bearing size.

5. A method of monitoring performance parameters for a mechanical press, comprising:

generating a theoretical no load slide displacement curve for the press;

generating an actual slide displacement curve during a load condition of the press;

determining the contact point on the actual slide displacement curve which corresponds to the slide contacting the stock material;

establishing a start point on the slide downstroke between top dead center and the contact point;

establishing an end point on the slide upstroke between top dead center and the contact point;

identifying the points on the theoretical slide displacement curve corresponding to the start point and the end point;

identifying the points on the actual slide displacement curve corresponding to the start point and the end point;

superimposing the identified start points on the theoretical and actual slide displacement curves; and

superimposing the identified end points on the theoretical and actual slide displacement curves so that the theoretical and actual slide displacement curves can be compared to obtain indicators of press performance.

6. The method of Claim 5, wherein said step of generating a theoretical no load slide displacement curve comprises:

providing an equation that can be utilized to calculate slide displacement as a function of press speed, the equation including variables corresponding to press drive mechanism, connecting rod length, stroke length, and bearing size;

determining the speed of the press;

determining the appropriate variable corresponding to the press drive mechanism of the mechanical press;

determining the appropriate variable corresponding to the connecting rod length of the mechanical press;

determining the appropriate variable corresponding to the stroke length of the mechanical press;

determining the appropriate variable corresponding to the bearing size of the mechanical press;

providing a computational device;

communicating the equation, the speed of the press and the equation variables to the computational device;

calculating the theoretical distance above bottom dead center for each time increment of a slide stroke; and

plotting the calculated distance above bottom dead center values vs. time.

7. The method of Claim 5, wherein said step of generating an actual slide displacement curve during a load condition of the press comprises:

monitoring the displacement of the slide of the press; and

plotting slide displacement vs. crank angle.

8. The method of Claim 5, wherein said step of generating an actual slide displacement curve during a load condition of the press comprises:

monitoring the displacement of the slide of the press; and

plotting slide displacement vs. time.

9. The method of Claim 5, wherein said step of generating an actual slide displacement curve during a load condition of the press comprises:

monitoring the displacement of the slide of the press using a non-contact displacement sensor; and

plotting slide displacement vs. crank angle.

10. The method of Claim 5, wherein said step of generating an actual slide displacement curve during a load condition of the press comprises:

monitoring the displacement of the slide of the press using a non-contact displacement sensor; and

plotting slide displacement vs. time.

11. The method of Claim 5, wherein said step of determining the contact point on the actual slide displacement curve comprises:

determining the first inflection point on the actual slide displacement curve; and

establishing the contact point on the actual slide displacement curve as the first inflection point on the actual slide displacement curve.

12. The method of Claim 5, further comprising:

calculating the distance between the theoretical slide displacement curve and the actual slide displacement curve at a plurality of increments on the slide upstroke between the contact point and the end point;

calculating initially the sum of the distances between the theoretical slide displacement curve and the actual slide displacement curve at each increment;

shifting the actual slide displacement curve;

recalculating the sum of the distances between the theoretical slide displacement curve and the actual slide displacement curve at each increment; and

repeating the shifting and recalculating steps until the sum of the distances between the theoretical slide displacement curve and the actual slide displacement curve at each increment reaches a minimum value.

13. The method of Claim 5, further comprising:

determining a value of dynamic deflection;

determining the value of static stiffness for the press being monitored;

providing a computational device;

communicating the value of dynamic deflection and the value of static stiffness to the computational device; and

calculating load on the press at any point of the slide stroke by multiplying the value of dynamic deflection for the relevant point of the slide stroke by the value of static stiffness.

14. The method of Claim 13, wherein said step of determining a value of dynamic deflection comprises:

measuring the distance along the ordinate between the theoretical no load slide displacement curve and the actual slide displacement curve.

15. The method of Claim 14, further comprising:

calculating load on the press for each time increment of a slide stroke; and

plotting calculated load vs. time.

16. A method of monitoring load on a mechanical press without using a contact load sensor, said method comprising:

determining a value of dynamic deflection;

determining the value of static stiffness for the press being monitored;

providing a computational device;

communicating the value of dynamic deflection and the value of static stiffness to the computational device; and

calculating load on the press at any point of the slide stroke by multiplying the value of dynamic deflection for the relevant point of the slide stroke by the value of static stiffness.

17. The method of Claim 16, wherein said step of determining a value of dynamic deflection comprises:

generating a theoretical no load value of slide displacement;

generating a calculated actual load value of slide displacement corresponding in time to the theoretical no load value of slide displacement;

computing the difference between the theoretical no load value and the actual load value of slide displacement; and

establishing the difference between the theoretical no load value and the actual load value of slide displacement as the value of dynamic deflection.

18. The method of Claim 16, further comprising:

determining a plurality of values of dynamic deflection at increments of the entire slide stroke; and

calculating a plurality of load values corresponding to the plurality of dynamic deflection values.

19. The method of Claim 18, further comprising:

generating a plot of load vs. time for a slide stroke of the press.

20. An apparatus for monitoring a running press, comprising:

a speed sensor for sensing a value of press speed;

input means for inputting a plurality of variables corresponding to characteristics of the press; and

storage means for storing an equation which can be used for generating the theoretical slide displacement curve, said equation utilizing said plurality of variables corresponding to characteristics of the press and said value of press speed to generate the theoretical slide displacement curve;

a computational device for generating the theoretical slide displacement curve, said computational device communicatively connected to said sensor means, said input means and said storage means; and

a non-contact displacement sensor for sensing slide displacement during an actual load condition of the press, said non-contact displacement sensor communicatively connected to said computational device, said computational device plotting sensed slide displacement vs. a count quantity, said computational device determining the contact point on the actual slide

displacement curve which corresponds to the slide contacting the stock material, said computational device establishing a start point on the slide downstroke between top dead center and the contact point, said computational device establishing an end point on the slide upstroke between top dead center and the contact point, said computational device identifying the points on the theoretical slide displacement curve corresponding to the start point and the end point, said computational device identifying the points on the actual slide displacement curve corresponding to the start point and the end point, said computational device superimposing the identified start points on the theoretical and actual slide displacement curves, said computational device superimposing the identified end points on the theoretical and actual slide displacement curves so that the theoretical and actual slide displacement curves can be compared to obtain indicators of press performance.

21. The apparatus as recited in Claim 20, wherein said computational device comprises:

a microprocessor.

22. The apparatus as recited in Claim 20, wherein said plurality of variables comprises:

a value of connecting rod length;

a value of stroke length;

a value of drive type; and

a value of bearing size.

23. The apparatus as recited in Claim 20, wherein said count quantity is a measure of time.

24. The apparatus as recited in Claim 20, wherein said count quantity is a measure of crank angle.

25. An apparatus for monitoring the load on a mechanical press, comprising:

a speed sensor for sensing the speed of the press;

a non-contact displacement sensor for sensing slide displacement during an actual load condition of the press;

input means for inputting a plurality of variables corresponding to characteristics of the press; and

a computational device, said computational device communicatively connected to said speed sensor, said non-contact displacement sensor and said input means, said computational device computing a theoretical no load value of slide displacement, said computational device computing a value of dynamic deflection by computing the difference between the theoretical no load value and the corresponding actual load value of slide displacement, said computational device multiplying the value of dynamic deflection by the value of static stiffness of the mechanical press to determine a value of load on the press at a point of the slide stroke.

26. The apparatus as recited in Claim 25, wherein said plurality of variables comprises:

a value of static stiffness corresponding to the press being monitored;

an equation for generating theoretical slide displacement values, said equation including variables corresponding to press drive mechanism, connecting rod length, stroke length, and bearing size;

a value of connecting rod length;

a value of stroke length;

a value of drive type; and

a value of bearing size.

respectfully request the withdrawal of the drawing objections set forth on pages 2 and 3 of the Office Action.

Responsive to the objection to the abstract to the disclosure, Applicants have submitted a new abstract herewith, keeping in mind the comments offered by the Examiner. (The new abstract can be found on a separate sheet at the end of this Office Action.) Applicants submit that the new abstract is in allowable form.

Responsive to the objection to the disclosure based on informality found at page 19, lines, 8-9, Applicants have amended the specification, keeping in mind the comments offered by the Examiner. The Applicants submit that no new matter has been added by such an amendment and that the disclosure is now in allowable form.

Responsive to the rejection of claims 1-4, 6, 11, 20-24, and 26 under 35 U.S.C. §112, first paragraph, Applicants hereby respectfully traverse this rejection. Applicants submit that curve-fitting equations are well known and are set forth in various text books. One such text book is <u>Numerical Analysis</u>, third edition, written by R.L. Burden and J.D. Faires and published by Prindle, Weber & Schmidt (© 1985). Applicants submit that the claims are sufficiently enabled by the disclosure and hereby respectfully request that the rejection under 35 U.S.C. §112, first paragraph, be withdrawn.

With respect to the rejection of claim 11 under 35 U.S.C. §112, first paragraph, as failing to provide one of ordinary skill in the art with the purpose or advantage for using the first inflection point on the actual slide displacement curve for establishing the contact point thereon, Applicants hereby respectfully traverse this rejection. 35 U.S.C. §112, first paragraph, only requires that the written description set forth how to make and use the invention and to set forth the best mode contemplated by the inventor. There is no requirement set forth therein with respect to providing a purpose or advantage of performing a particular method step. Further, with respect to using the first inflection point on the actual slide displacement curve for establishing the contact point thereon, it is well known in the mechanical press art that an inflection occurs when the slide contacts the metal being formed due to inertial effects. As such, that first inflection point corresponds to the point at which the slide contacts the metal. Thus, Applicants submit that Claim 11 is sufficiently supported by the specification and hereby respectfully request that the rejection of claim 11 under 35 U.S.C. §112, first paragraph, be withdrawn.

Responsive to the rejection of claim 12 under 35 U.S.C. §112, second paragraph, Applicants have amended claim 12, keeping in mind the comments offered by the Examiner. Applicants submit that claim 12, as amended, is now in allowable form.

Responsive to the rejection of claims 1 and 3 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. Re.34,559 (Mickowski) in view of U.S. Patent No. 5,182,135 (Schockman), Applicants hereby respectfully traverse this rejection and submit that claims 1 and 3 are in condition for allowance.

Claim 1 recites in part:

> providing an equation that can be utilized to calculate slide displacement as a function of press speed, the equation including variables to account for press parameters which effect slide displacement;
>
> providing a computational device;
>
> determining the speed of the press;
>
> determining the equation variables;
>
> communicating the equation, the speed of the press and the equation variables to the computational device;
>
> calculating the theoretical distance above bottom dead center for each increment of a slide stroke; and
>
> plotting the calculated distance above bottom dead center values vs. time.

Applicant submit that such an invention is neither taught, disclosed, nor suggested by Mickowski, Schockman, or any of the other cited references, alone or in combination.

The Examiner admits that Mickowski fails to teach an equation for calculating the slide displacement as is claimed in claim 1. However, the Examiner asserts that Schockman inheritly provides some type of equation or formula to translate variable

information into load and displacement curves. While the section of Schockman relied upon the Examiner (column 4, lines 5-24), does set forth various parameters, there is no indication therein of the use of an equation to calculate slide displacement based upon such information. Further, there is no indication that the displacement curves shown in Fig. 6 are indeed theoretically generated or display an actual force versus angle plotting. Consequently, there is insufficient disclosure in Schockman to state that Schockman inherently sets forth providing an equation that can be utilized to calculate slide displacement as a function of press speed, the equation including variables to account for press parameters which effect slide displacement, as set forth in claim 1. Therefore, Applicants submit that the combination of Mickowski in view of Schockman fails to teach or suggest the invention as set forth in claim 1.

In a similar matter, claim 3 recites in part:

> storage means for storing an equation which can be used for generating the theoretical slide displacement curve, said equation utilizing said plurality of variables corresponding to characteristics of the press and said value of press speed to generate the theoretical slide displacement curve;...

Applicants submit that such an invention is neither taught, disclosed, nor suggested by Mickowski, Schockman, or any other of the cited reference, alone or in combination for similar reasons as set forth with respect to claim 1. Therefore, Applicants

submit that claims 1 and 3 are now in condition for allowance and respectfully request the withdrawal of the rejection thereof.

Claims 2 and 4 were rejected under 35 U.S.C. §103(a) as being unpatentable over Mickowski in view of Schockman and further in view of U.S. Patent No. 5,099,731 (Eigenmann). However, claims 2 and 4 depend from claims 1 and 3, both of which are in condition for allowance for the reasons set forth above. Therefore, Applicants submit that claims 2 and 4 are also in condition for allowance.

Responsive to the rejection of claims 5, 7-10, 20, 21, 23 and 24 under 35 U.S.C. §103(a) as being unpatentable over Mickowski in view of Schockman and further in view of U.S. patent No. 5,113,756 (Fujii) and U.S. Patent No. 5,555,757 (Smith et al), Applicants hereby respectfully traverse this rejection and submit that claims 5, 7-10, 20, 21, 23, and 24 are in condition for allowance.

The Examiner admits that Mickowski and Schockman fail to teach determining the contact point on the actual slide displacement curve which corresponds to the slide contacting the stock material, establishing a start point on the slide down stroke between top dead center and the contact point, and establishing an end point on the slide upstroke between top dead center and the contact point.

The Examiner asserts that Fujii teaches a method for determining an adjusting the die height of a press machine that includes a non-contact sensor used to indicate contact between the slider and the bottom dead position of the press as well as the contact between the slider and the top dead position of the press. As set forth, in column 6, lines 9-31, thereof, Fujii provides a bottom dead point position detector 55 and a top dead point position detector 58, which together allow detection of the slider when it reaches one of these points. However, there is no provision of a detector that is capable of determining the position of the slider at any points intermediate the bottom dead point and the top dead point. As defined by the present specification, at contact point 60 the slide contacts the stock material (page 18, lines 10-15), contact point 60 thereby being intermediate the top dead center and the bottom dead center. Therefore, Fujii fails to teach or suggest the step of determining the contact point on the actual slide displacement curve, as set forth by the present invention as claimed.

The Examiner relies upon Smith et al. as a disclosure of a slide drive system that reciprocates in response to the CAM rotation and for an accompanying diagram for illustrating the displacement curve for a slide in comparison with a reference displacement curve. Smith et al. do not teach or suggest the establishment of a start point on the slide downstroke between

top dead center and the contact point, nor does Smith et al teach or suggest the establishment of an end point on the slide upstroke between the top dead center and the contact point. Furthermore, Smith et al do not teach or suggest matching the actual slide displacement curve to the theoretical no load slide displacement curve for the same mechanical press. As seen from column 11, lines 11-14, Smith et al. provide an acceleration curve for their invention and an acceleration curve for a typical prior art crank-and-pitman type thread roller (shown in dotted line form). As such, the acceleration curve of the invention is not compared to a theoretical acceleration curve for that invention. Therefore, Smith et al provide no reason or motivation to attempt to match the acceleration curve provided by the CAM and follower linkage drive of their invention with the acceleration curve provided in a typical prior art crank-and-pitman-type thread roller in a manner similar to that set forth for matching the actual displacement curve to the theoretical displacement curve of the present invention. Thus, Smith et al. fail to teach or suggest the present invention as claimed.

Thus, for all the foregoing reasons, Applicants submit that claims 5, 7-10, 20, 21, 23, and 24 are now in condition for allowance and respectfully request the withdrawal of the rejection thereof based upon the combination of Mickowski in view of Schockman, Fujji, and Smith et al.

Claims 6 and 22 were rejected under 35 U.S.C. §103(a) as being unpatentable over Mickowski in view of Shockman, Fujii, and Smith et al, and further in view of U.S. Patent No. 5,099,731 (Eigenmann). However, claim 6 depends from claim 5 and claim 22 depends from claim 20, with claims 5 and 20 being in condition for allowance for reasons set forth above. Therefore, Applicants submit that claims 6 and 22 are also in condition for allowance and hereby respectfully request the withdrawal of this rejection.

Responsive to the rejection of claims 13 and 16 as being unpatentable over Mickowski in view of Shockman, Eigenmann, Fujii, and Smith et al, and further in view U.S. Patent No. 5,870,254 (Baserman et al), Applicants hereby respectfully traverse this rejection and submit that claims 13 and 16 are in condition for allowance.

The Examiner admits that Mickowski in combination with Shockman, Eigenmann, Fujii, and Smith et al fail to teach or suggest including a value of static stiffness with the other obtained press information and calculating the load on the press at any point of the slide stroke by multiplying the value of the dynamic deflection for the relevant point of the slide stroke by the value of static stiffness. The Examiner relies on Baserman et al which discloses the determination of the amount of gram load loss due to the unbalanced lifting forces existing in the actuator arms in a computer disk drive system. One such means

set forth by Basermann et al is to use finite element analysis to calculate the deflection and rotation of the arm tip when nominal lifting forces are applied at the slider, each slider in this instance being one of transducer sliders 160-170. While Baserman et al does multiply deflection by vertical stiffness to determine the decrease in gram load, Baserman et al does not calculate the load at any point on a slide stroke of a mechanical press, as is currently claimed.

Moreover, the Baserman et al reference is not analagous art and is not used to solve the same problem as the present invention. The unbalanced forces being detected in relation to the disk drive of Baserman et al are on the order of a few grams, while those being detected with respect to the present invention are on the order of tons. Additionally, there is no disclosure or suggestion in Baserman et al that the decrease in gram load is to be determined at various points along the transducer slider.

For all the foregoing reasons, Applicants submit that claims 13 and 16 are in condition for allowance and respectfully request the withdrawal of the rejection thereof.

Claims 14, 15, 17-19, 25, and 26 were rejected under 35 U.S.C. 35 §103(a) as being unpatentable over Mickowski in view of Shockman, Eigenmann, Fujii, Smith et al, and Baserman et al, and further in view of U.S. Patent No. 3,885,283 (Biondetti). Claims 14 and 15 depend from claim 5; and claims 17-19 depend from claim

16, claims 5 and 16 being in condition for allowance for reasons set forth above. Thus, Applicants submit that claims 14, 15, and 17-19 are also in condition for allowance, the allowance which is hereby respectfully requested.

Claim 25 recites in part:

> a computational device, <u>said computational device communicatively connected to</u> said speed sensor, <u>said non-contact displacement sensor</u> and said input means, said computational device <u>computing a theoretical no load value of slide displacement</u>, said computational device computing a value of dynamic deflection by computing the difference between the theoretical no load value and the corresponding actual load value of slide displacement, said computational device <u>multiplying the value of dynamic deflection by the value of static stiffness</u> of the mechanical press <u>to determine a value of load on the press at a point of the slide stroke.</u>

(Emphasis added.) Applicants submit that such an invention is neither taught, disclosed, or suggested by any of the cited references, alone or in combination.

The shortcomings of Mickowski, Shockman, Eigenmann, Fujii, Smith et al, and Baserman et al, with respect to the present invention as set forth in claim 25 have been discussed previously, and Biondetti does not overcome the shortcomings. For example, Biondetti does not disclose or suggest a non-contact displacement center for sensing slide displacement; and/or a computational device capable of computing a theoretical no-load value of slide displacement and/or capable of multiplying the value of dynamic deflection by the value by the value of static

stiffness of the mechanical press to determine a value of load on the press at a point of the side stroke, such as set forth by claim 25. Therefore, Applicants submit that claim 25, and claim 26 depending therefrom, are in condition of allowance and hereby respectfully request the withdraw of the rejection thereof.

If the Examiner has any questions or comments that would speed prosecution of this case, the Examiner is invited to call the undersigned at 260/485-6001.

Respectfully submitted,

Randall J. Knuth
Registration No. 34,644

RJK/ste10

Encl.: Replacement Claims
Marked-up Claims
Return Postcard

RANDALL J. KNUTH, P.C.
3510-A Stellhorn Road
Fort Wayne, IN 46815-4631
Telephone: 260/485-6001
Facsimile: 260/486-2794

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